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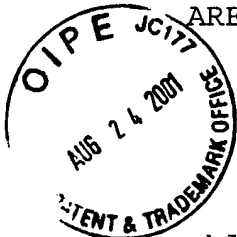
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of :
JEAN-FRANCIS KISOVEC et al. : Group Art Unit: 2633
Serial No.: 09/870,924 :
Filed: June 01/2001 :
For: MULTIMEDIA OPTICAL COMMUNITY :
AREA NETWORK :



SUBMISSION OF PRIORITY DOCUMENT

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Washington, D.C. 20231

Dear Sir:


Submitted herewith is a certified copy of Applicant's British Patent Application No. 0013366.0, filed June 1, 2000. The right of priority has been claimed pursuant to the provisions of 35 U.S.C. §119.

It is respectfully requested that receipt of this priority document be acknowledged.

Respectfully submitted,

Date: _____

8/24/01



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P01/7700 0.00-0013366.0

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1. Your reference

MDS/AT

2. Patent application number

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0013366.0

- 1 JUN 2000

3. Full name, address and postcode of the or of each applicant. (underline all surnames)

VIPswitch Inc
8 Commerce Place, Suite 200,
Brossard, Quebec,
Canada J4W 3H2

Patents ADP number (if you know it)

7909492001

If the applicant is a corporate body, give the country/state of its incorporation

Canada

4. Title of the invention Optical Communicator

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Bromhead & Co., 19 Buckingham Street,
London, WC2N 6EF

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Signature

Dr Michael D Spencer Date *1 June 2000*

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020-7976 1022

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OPTICAL COMMUNICATOR

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1 INTRODUCTION

This project consisted in creating an optic communicator that could be used in local networks (LAN: Local Area Network) at the speed of Ethernet Gigabits (IEEE 802.3Z) such as 1.25 Gb/s [1]. The first goal is to increase the capacity of the system by using a Wavelength Division Multiplexing (WDM). Another factor was that this system use cost efficient components.

2 Presentation of Optic Communicator

2.1 General structure of the optic communicator

General structure of the splice used in the optic communicator is shown on Diagram 1.

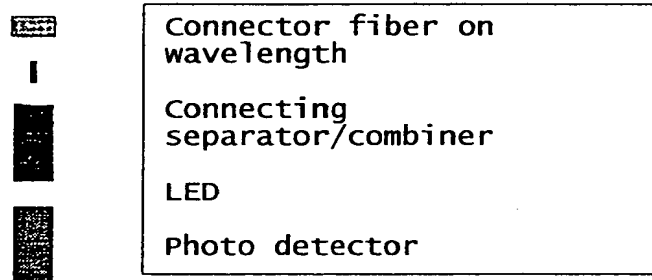
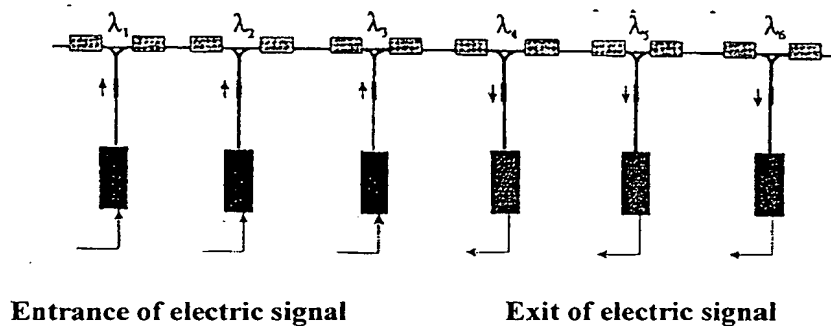


Diagram 1: Diagram is based on the splice using the optic communicator.

The main principle of the splice is based on using several wavelengths (WDM) to increase the capacity of the transmission. The example in diagram 1 shows the splice using several transmitters (LED) and receivers (photo detectors). Selected connectors on wavelengths will allow an optic screening of the transmission and the reception. The capacity of the transmission of this particular splice is increased by the equivalent factor of the wavelengths used. In the configuration of diagram 1, the system is also bi-directional. Since this splice is found inside the local network, all the components should be of low cost.

Let us see how the theoretical function is used in a global context, when several splices are present. Diagram 2 demonstrates a configuration Bus system where 4 splices are present.

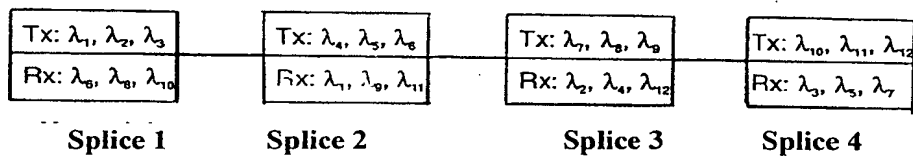


Diagram 2: Configuration Bus system containing 4 splices.

To attain the desired splice, the splice that transmits information must select the right wavelength. For example, if splice 2 wants information from splice 4, splice 2 must transmit a λ_3 .

Since the system is bi-directional and has a number of wavelengths available, all of the splices present in the system can communicate with all the other splices.

In such a system, the number of wavelengths (L) that are available depends on the factor of the capacity that the transmission can be increased (M) and the number of splices present (N).

We obtain $L = M \times N$. We observed that a system processing several splices, the amount of wavelengths would be sizeable; the cost of this becomes essential since each wavelength uses 1 transmitter and 1 receiver.

2.2 Structure of the splice achieved in the laboratory

Finally, to show the main operation, diagram 3 shows the splice that we have achieved in the laboratory.

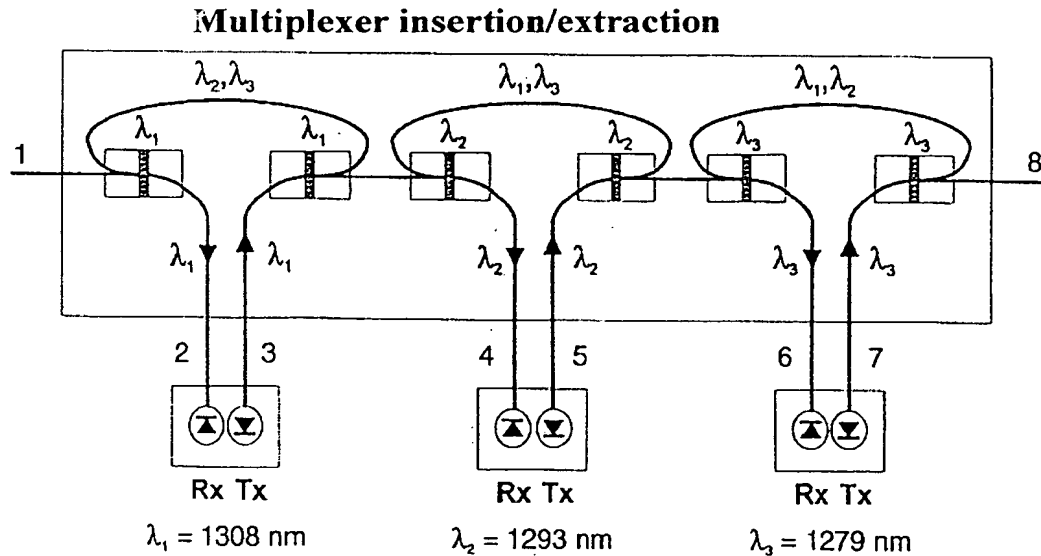


Diagram 3: Diagram of splice achieved in the laboratory

In this splice achieved in the laboratory, the transmitters (Tx) used are the LEDs operating in the range of 1300 nm and can be adjusted up to 622 Mb/s. The choice of wavelength is imposed by the GbE standard and also by the fact that minimal scattering at this wavelength in the optical fiber. Ideally, it would have been preferable that LEDs would be available if it could be modulated at 1.25 Gb/s; unfortunately this type of product is not commercially available. However, such a speed using a LED has already been shown in laboratory [2]. Each Tx processes its own LED and the choice of wavelength to transmit will be achieved with different "spectral slicing" [3] will be found inside the multiplexer insertion/extraction.

The receivers are the detectors APD coupled to a transimpedance amplifier; together processing significantly up to -42 dBm. Obviously, to have a low costing system, the choice of this type of receiver is not optimal since it's costly. Within the framework of this prototype, the detectors guarantee the capabilities of showing the functioning guidelines. To use low costing detectors (PIN) the signal at each receiver door must be -25 dBm. Using the components already available, the detectors PIN are incompatible because of the low optic power available at each of the receiver doors. Just like the transmitters signals, the selection of wavelengths to the receivers is made through dichromatic filters.

We have noted in diagram 3, the multiplexer insertion/extraction is composed of a cascade of dichromatic fibers. The wavelength station of each of the fibers are as follows: $\lambda_1 = 1308\text{nm}$, $\lambda_2 = 1293\text{ nm}$ and $\lambda_3 = 1279\text{ nm}$. The width of wave band at mid-height (FWHM) for each of the fibers vary between 5 and 10nm depending of the door used.

The fiber used in all the components of the splice is multimode fiber 62.5/125 μm . This fiber is specifically required for the GbE standard.

3 Characteristics of Optic transmitters

In this section, we will be presenting the characteristics of the optic transmitters (LED) used in this project. The principle characteristics of the components are illustrated in table 1. The completed specifications are given in annex A.

Type	Wavelength	Width of band (FWHM)	Power flow of Optic (CW) in Fiber	Maximum speed	Maximum (crete) current
LED	1320 nm	130nm	-17 dBm (20uW)	622 Mb/s	130mA

Table 1: Main characteristics of optic transmitters (LED) used.

In the context of this project, 5 LEDs were bought. Within this batch, 1 LED was defective so it was returned to the supplier. Even though this LED was replaced, the following measures were accomplished with the functioning 4 LEDs.

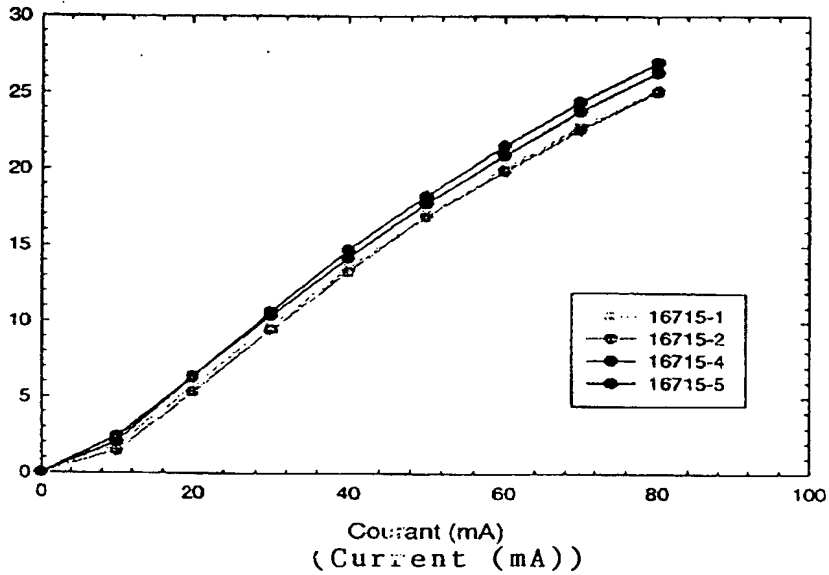
3.1 Power and optic spectrum of LEDs

In Diagram 4 power curve vs current (L-I) in process CW also the optic spectrum observed at the exit of the multimode fiber (62.5/125 μm) of each of the LEDs. The optic power was measured with a meter power caliber while the optic spectrum was measured with the help of an optic spectrum analyzer with a resolution of 1nm.

As we have noted in diagram 4, the characteristics of 4 LEDs tested were very uniform. We also noticed that concerning the wavelengths of dichromatic filters of the multiplexer insertion/extraction, the wavelength station of LEDs (~1360 nm) is slightly offline. The outcome being that the available power of each door is not optimal since the maximums of each component does not match. In accomplishing the final product, we will have to insure that the maximums of the components match adequately to acquire a maximum power transmitted and received.

(Output power of the fibre (uW))
Puissance à la sortie de la fibre (uW))

Curves L-I of LEDs with fiber 62.5/125 um



Spectrums of 80 mA (RB: 1nm) of LEDs

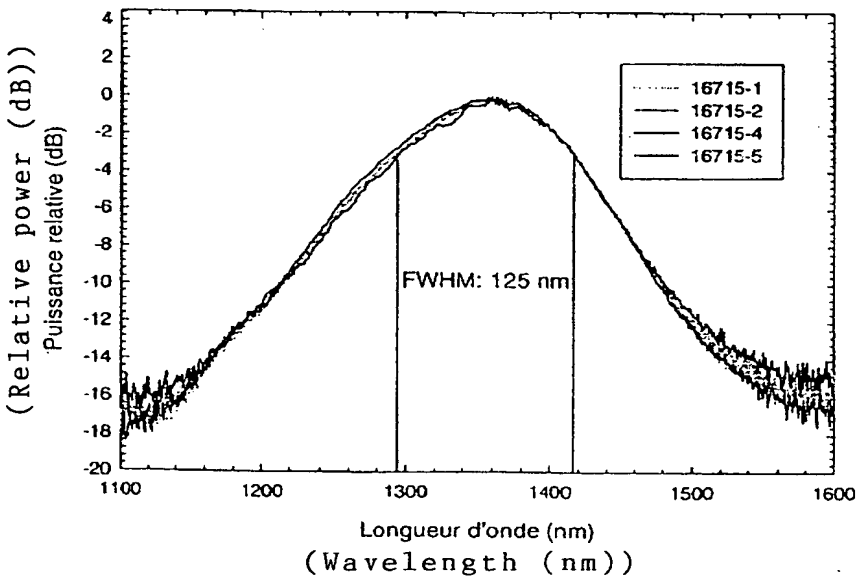


Diagram 4: power curve flow vs current in CW and optic spectrum of LEDs.

4 Features of splice achieved in Laboratory

4.1 Demonstration of Function guidelines

Finally to demonstrate the functioning guidelines of splices achieved in the laboratory, one of the LEDs in diagram 4 were injected in door 1 (refer back to diagram 3 for the door location). Light is detected with the help of an analyzer for optic spectrums in doors 2, 4 and 6. The obtained results are presented in Diagram 5. We can expect in this case the power distribution of the spectrum in LED, shows the power flow detected is weaker in short wavelengths.

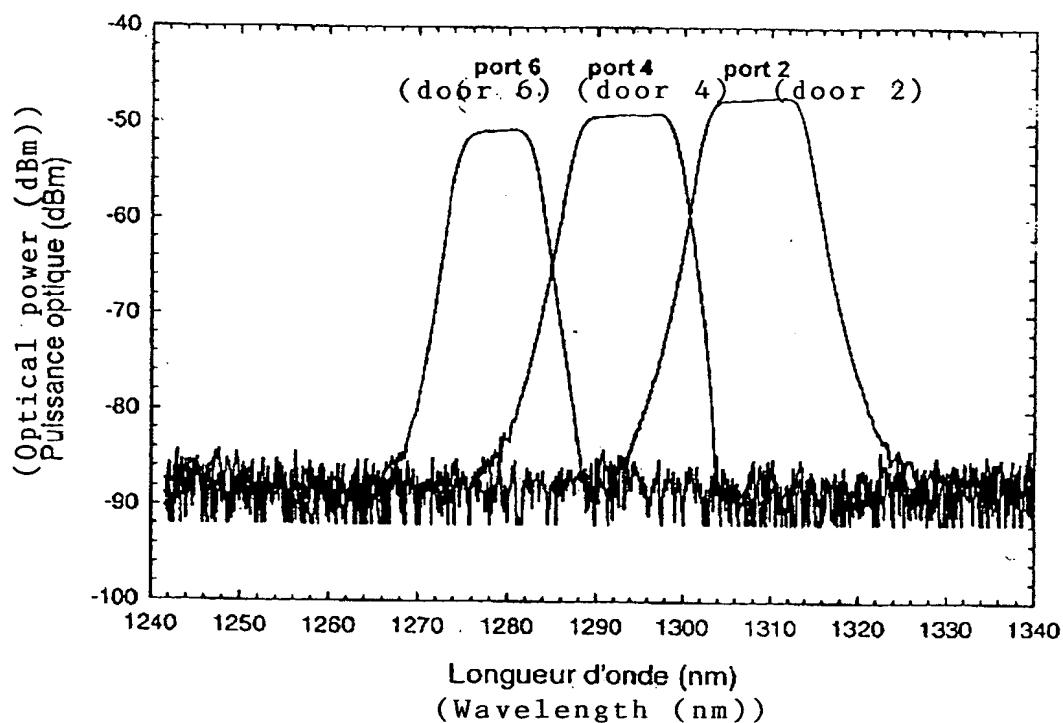


Diagram 5: Optic spectrum observed in doors 2,4 and 6 when the LED was injected in door 1.

4.2 Results theoretical and experimental of method CW

In this section, we are presenting the theoretical results obtained with the help of calculations using MathCad concerning the power obtained in receivers when using specifications of LEDs in diagram 4. The results are afterwards compared with the experimental results obtained using the fabricated splice in laboratory (diagram 3). The goal of these simulations are first to confirm validation of the theoretical design used and afterwards determines the width of the wave band of filters and the total power of LED so that we could use detectors PIN at a low cost (-25 dBm). It is important to mention that the sensitivity to detect the detector PIN corresponds with the average value detection of a modulation. These simulations are accomplished during the spectrum of the LED is centered on the wavelength of filters actually used in the multiplexer insertion/extraction.

Parameters of simulations:

- Injection in door 1 and detection in doors 2, 4 and 6.
- Total optic power: -16.55 dBm (22.12 μ W)
- Lose at different doors: door 2: 0.5 dB, door 4: 1.25 dB, door 6: 2 dB
- Spectrum form of filters: gaussian
- Width at mid-height of filters: 5 and 10 nm
- Spectrum form of LEDs: 1360 nm
- Width at mid-height of LEDs: 125 nm

The results of simulations and the results from experiments are shown in Table 2.

Detector Door	Simulation		Experience
	5 nm	10 nm	Between 5 and 10 nm
1279 nm (door 6)	-37.3dBm	-34.3 dBm	-35.3 dBm
1293 nm (door 4)	-35 dBm	-32 dBm	-32.2 dBm
1308 nm (door 2)	-32.9 dBm	-29.8 dBm	-30.1 dBm

Table 2: optic power obtained in doors 2, 4 and 6 when the light is injected in door 1. The results of the simulations and the experiments are compared for different widths of wave band.

When analyzing the results obtained in Table 2, we realized that the simulations and experiment coincided very well. Also, the tendency of the results obtained is similar to the results presented in Diagram 5. Table 3 represents the results of the simulation when assuming that the wavelength station of the LED is sent to 1293 nm in other words the spectrum is centered on the dichromatic filters. The other parameters in the simulations remained unchanged.

Detector Door	Simulation	
	5 nm	10 nm
1279 nm (door 6)	-32.4 dBm	-29.4 dBm
1293 nm (door 4)	-31.5 dBm	-28.5 dBm
1308 nm (door 2)	-30.9 dBm	-27.9 dBm

Table 3: Optic power obtained in doors 2, 4 and 6 when the light was injected in door 1 in assuming the wavelength station of LED is 1293 nm.

We noted even in using the LEDs actually centered in wavelength in comparison with different channels, it is not possible to obtain the necessary power to use the PIN detectors.

Two other solutions can be considered to increase the power detected by different receivers: 1) increase the width band of filters or 2) use more powerful LEDs. In both cases, the power flow of different detectors is directly proportional to the width band and the total power injected into the system.

Referring to Table 2 where the LEDs are centered at 1360 nm, we noticed that in the worst of cases (door 6 at 1279 nm), to obtain a power flow of -25 dBm, the width band that should be used must be 80nm. Therefore, we're saying the maximum used would be 2 channels. Also, since the width bands are so high, the effects of breaking up could become important if long distances are considered which would create deterioration of the quality of the received signal.

The best solutions rest in using more powerful LEDs. When using the multiplexer insertion/extraction it actually has filter widths of ~10 nm, the total power of LEDs should be within 0.5 mW. In such a case, using a dozen channels would be possible. Unfortunately, this type of components to be modulated at speeds compatible to GbE are not available on the market.

4.3 Demonstration of Bi-directional System

Up till now, the results presented assuming that the light was injected via the door 1 (light coming from another splice) and detected on different doors 2,4 and 6 of the multiplexer. The experimental measures were also accomplished in the case where injection was made in doors 2 to 7. The results were presented in Table 4. As per the previous cases, the total power coming from the LED is – 16.55 dBm.

Injection Door (-16.55 dBm)	Door 1	Door 8
Door 7 (1279 nm)	-61 dBm	-33.4 dBm
Door 6 (1279)	-35.5 dBm	-61.6 dBm
Door 5 (1293)	61.1 dBm	-33 dBm
Door 4 (1293)	-32.3 dBm	-60.8 dBm
Door 3 (1308)	-61.4 dBm	-33.9 dBm
Door 2 (1308)	-30.3 dBm	-60.3 dBm

Table 4: Optic power flow obtained experimentally by doors 1 to 8 when light is injected into doors 2 to 7.

As you will notice in Table 4, the light exits doors 1 or 8 depending on the door exited (2, 4, 6) or entered (3, 5, 7) when injecting the light. The results confirm that the system can function bi-directionally when using a connector 50/50 to combine the entrance and exit doors associated to each wavelength. However, the use of this connector creates a surplus loose of the 3 dB.

To complete the bi-directional aspect of this system, we created a similar experience as the one in Table 2 however this time, the light was ejected in door 8 instead of door 1. Table 5 presents the power received in different doors confirming the bi-directionality of this system.

5 CONCLUSION

In this project, we have shown the functioning guidelines of a new type of optic communicator charged to function in the local network. This optic communicator uses the multiplexing of wavelengths to increase the capacity of the transmission and intended towards a specific splice. Ideally, this communicator should be a low cost product.